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THE BURNING BUILDING

FIRE ^{AS} PLACE



Winnie Tu

Bachelor of Architecture, 2016

Primary Advisor: Daekwon Park

Syracuse University

Thesis Preparation

Fall 2015

~~WE MADE A FIRE!~~

~~GATHER AROUND THE FIRE!~~

~~RUN! THERE'S A FIRE!~~

~~DON'T START A FIRE!~~

WHERE'S THE FIRE?



THE FIRE IS GONE FROM ARCHITECTURE



SUMMARY

The importance of fire in human social evolution is widely acknowledged but the extent of its impact is not fully explored. Generally, it is connected to energy, light, purification, illumination, creation, destruction and metamorphosis. Fire's paradoxical nature has built up many societies throughout human history and has been the primary social driver within communities. Due to technological advances, its energy has been transformed into a distant element which is being used discretely in industrial buildings, hidden under basements, or replaced by other forms of energy. Now, heat, energy, and light is readily available anywhere at any time, eliminating the biological need for a centralized source of life. As a result, fire has lost its original symbol in society as the life giving entity of the home and of the city. Strict fire regulations have further relinquished the use of fire in contemporary society. This ultimately plays a role in society's shift towards individualistic rather than collective organization - extinguishing the original formulation of community.

WHAT DRAWS US TOWARDS FIRE?

When fire is controlled, research confirms that hearth and campfires induce relaxation as part of a multi sensory, absorptive, and social experience. Because fire ties heavily with community formation, this thesis aims to directly re-introduce the element of fire as a social phenomenon measured through four scales of human proxemics: public, social, personal, and intimate. Since fire involves flickering light, crackling sounds, warmth, and has a distinctive smell, the architecture will be designed around the exploration of these characteristics and its spatial qualities through the control of construction as well as heat and light dissipation to result in the design of a cyclically transformative burning building.¹

¹[The idea of a “burning building” is being redefined not as a building being decayed, but rather a study of how reintroducing fire back into Architecture can create a centralized social phenomenon within the public realm through the design of a transformative process.]



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FIRE IS COMBUSTION
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SOCIAL PROXEMICS

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BURNING MAN

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FIRE AS PLACE
PHASE 1: BUILD IT
PHASE 2: BURN IT
PHASE 3: INHABIT IT
PHASE 4: REGENERATE

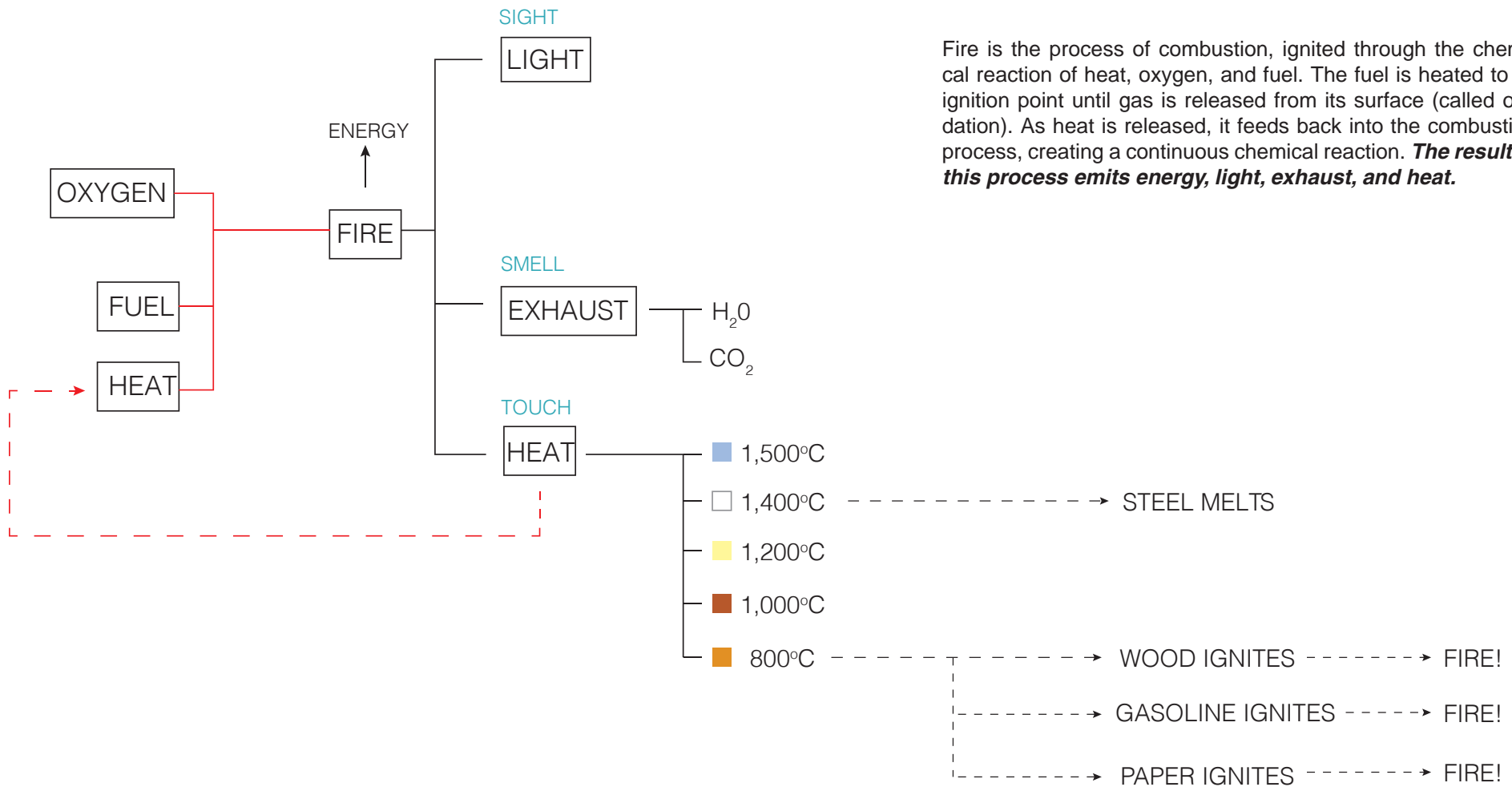
A large, bright bonfire is burning in the center of the frame against a dark night sky. The fire is composed of many logs and branches, with intense orange and yellow flames reaching upwards. The base of the fire is surrounded by dark, charred wood.

01

WHAT IS FIRE?

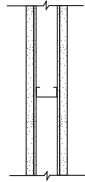
FIRE IS COMBUSTION

PROCESS OF FIRE

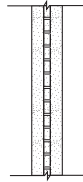


FIRE RATED WALLS AND PARTITIONS

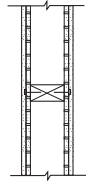
1 HOUR RATED



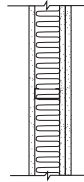
METAL STUDS,
GYPSUM PLASTER



STUDLESS SOLID
GYPSUM PLASTER

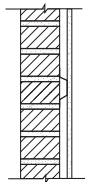


WOOD STUDS AND
GYPSUM PLASTER

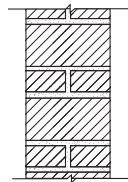


METAL STUDS, GYPSUM
WALLBOARD, MINERAL FIBER

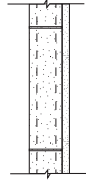
2 HOUR RATED



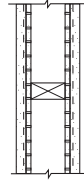
BRICK WITH 1/2" TYPE X
GYPSUM WALLBOARD



8" CLAY BRICK

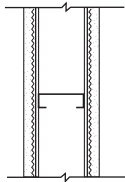


HALLOW GYPSUM
TILE AND PLASTER

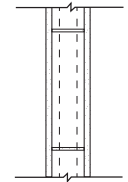


WOOD STUDS AND
GYPSUM PLASTER

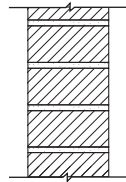
3 HOUR RATED



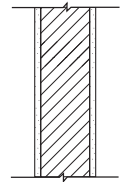
METAL STUDS AND
GYPSUM PLASTER



HALLOW GYPSUM TILE
AND PLASTER

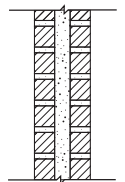


8" BRICK

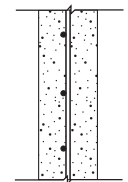


4" HALLOW BRICK

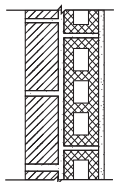
4 HOUR RATED



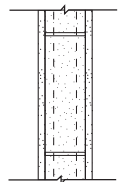
8" HALLOW BRICK,
LOOSE-FILL INSULATION



SOLID CONCRETE WALL
GRADES A AND B



CLAY BRICK AND
HALLOW CLAY TILE



HALLOW GYPSUM TILE
AND PLASTER

FIRE IS CONSTRUCTION

All buildings are designed around fire. The idea of fire infiltrates every aspect of contemporary architectural construction guided by building codes and fire regulations. The relation of this element in Architecture remains a passive one as buildings are constructed to resist and decelerate the effects of combustion. Fire is ultimately one of the largest influence of the built environment, whether it is present or not.



Peer Gastgir Sahib Shrine Fire, Resisting fire through the process of "slow burning" heavy timber construction Photo by Jason Pemberton, Photopedia.com



FIRE IS EXOSOMATIC

Exosomatic: Recording of memories outside the brain.

Fire has no precise consistency, but **its presence can actively transform matter into different states**. It can be agreed that it is a property transforming element which has the ability to physically manipulate objects in a short amount of time. Fire is the common medium which constantly changes the building's level of order by embedding its memories into the structure of the building.

FIRE IS PARADOXICAL

Fire stands as the origin of radiant **warmth and light**. Ultimately, the fireplace is the center of the house. It is the life giving element which transforms the building shell into a living entity.

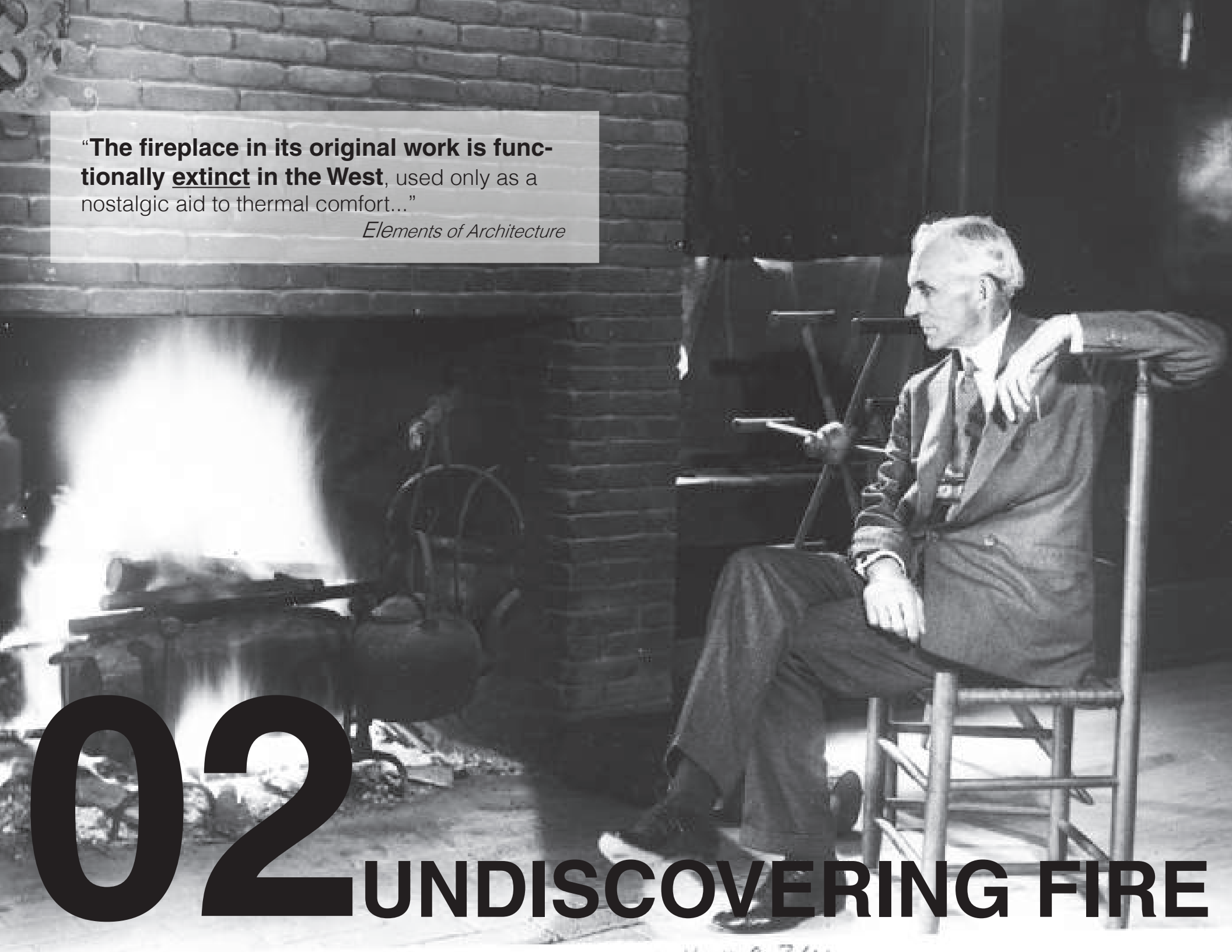
If not properly tended, its benign character can quickly become a **dangerous and apocalyptic** nightmare. It has the ability to swallow cities and forests - joining together things that were once separate and burning them until they become unrecognizable rubble.



CONTROLLED



UNCONTROLLED



“The fireplace in its original work is functionally extinct in the West, used only as a nostalgic aid to thermal comfort...”

Elements of Architecture

02 UNDISCOVERING FIRE

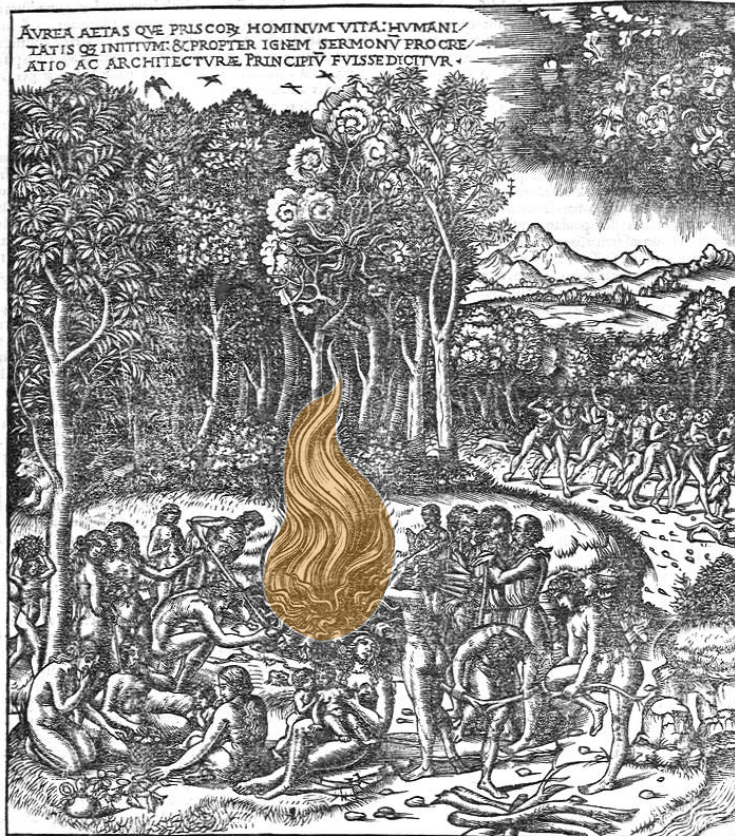
HOW WE EXPERIENCE FIRE IN CONTEMPORARY SOCIETY

“

Fire has been crucial to human survival for around one million years, and in that time, humans have evolved psychological mechanisms specifically dedicated to controlling it. But because most Westerners no longer learn how to start, maintain and use fire during childhood, we instead wind up with a curious attraction to it — a burning desire left to languish.”

-Wolchover





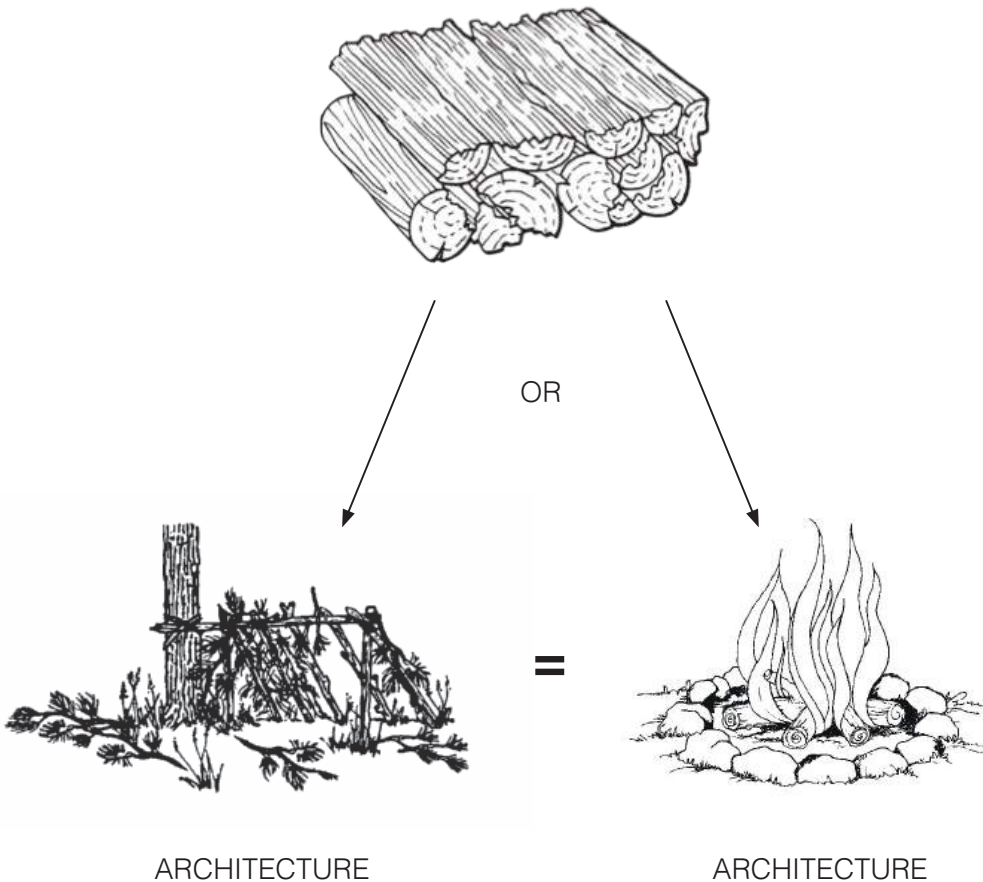
The discovery of fire in Cesariano's Vitruvius (1521).

BACKGROUND

"Fire is a synonym for the flow of life, which architecture serves."
-Josep Lluís Mateo

In ancient times, fire was seen as the primeval element, one of the many myths competing for the origin of how Architecture was formed. Fire is associated with energy, with the thermal adaptation needed for human life, and for handling and producing the materials, such as metal, glass, food, that are fundamental in survival.

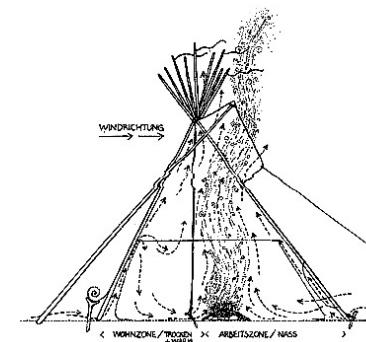
Generally, fire is connected to energy, light, purification, illumination, creation, destruction and metamorphosis. It has the properties of hot and dry, and once people ignited the first fire and gathered around it, it meant overcoming the hostility of the environment and adhering to the natural human needs. ***This has defined the first form of civilization and community.***

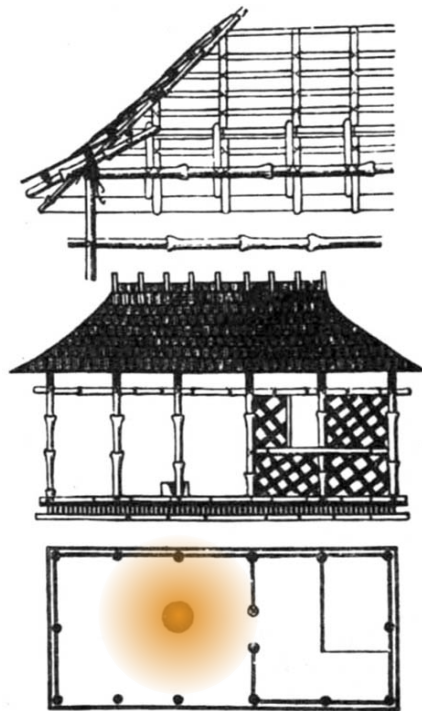


IS FIRE ARCHITECTURAL?

A parable presented by Reyner Banham can be used to illustrate the idea of this. The tale tells about a primitive tribe that has come upon a clearing in the woods where they plan to stay the night. The area is well supplied with fallen timber. Now the tribe faces a dilemma: should they use the wood to build a small shelter or as firewood for a bonfire?

Wood is a material for both construction and combustion. Both methods of use point out two architectural manifestations - one tangible and one intangible. The tribe considers two basic strategies of environmental intervention: regulating natural energy flows through physical structure (hut), or exploiting the energy brought by combustion (fire). ***The thermal space of the bonfire is no less architectural than the physical space of the hut.*** Fire presents a new form of spatial habitation expressed by the radiation of its heat, light, and energy. Moreover, its relations with the physical construction manifestation, the hut, is crucial in how space is oriented around it. What is a house but a hearth?





Primitive Hut, Semper, 1889

Fire + Architecture

"Throughout all phases of society, the hearth formed that sacred focus around which took order and shape. It is the first and most important element of architecture. Around it were grouped the other three elements: the roof, the enclosure, and the mound. The protecting negations or defenders of the hearth's flame against the hostile elements of nature."

-Gottfried Semper

Overtime, the idea of the fire and hut has developed into the fundamental elements of Architecture, where the fire is life and the building is the skin which shapes around it. ***The hearth becomes the center of spatial configuration.***

FENG-SHUI AND THE FIRE

Cave-pit-hut: evolution of dwellings, assisted by fireplace and the principles of feng-shui.

(Geomancy and the selection of architecture placement in ancient China, . Ding Yi, Lu Yu, Yong Hong, Hebei: 1996

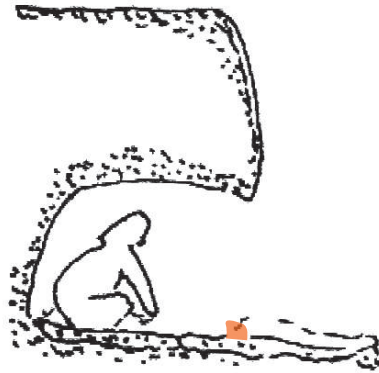


图 1-5 横穴
horizontal cave



图 1-6 过渡形态穴
cave in transitional period



图 1-9 半穴居前室后寝
half cave housing with a chamber at the front and a bedroom at the back

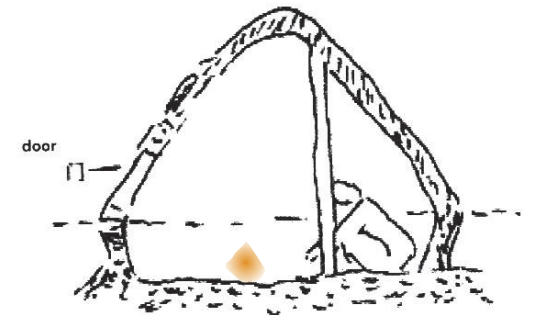


图 1-10 穴壁木骨泥墙，门仍开在屋上
cave wall with wooden frame and mud surfacing, the door is still on top of the house



图 1-7 袋形竖穴 (1)
bag-shaped vertical cave



图 1-8 袋形竖穴 (2)
bag shaped vertical cave

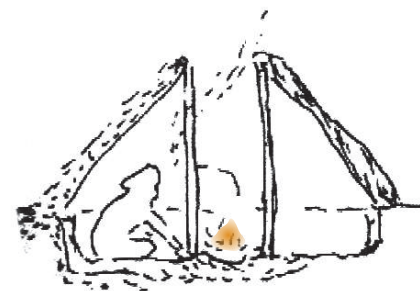
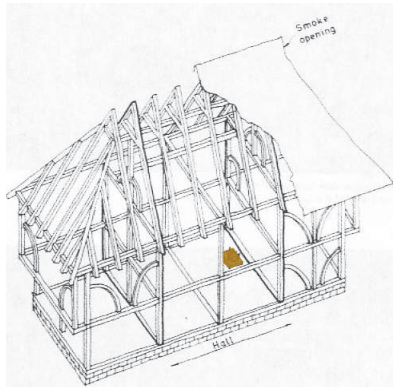


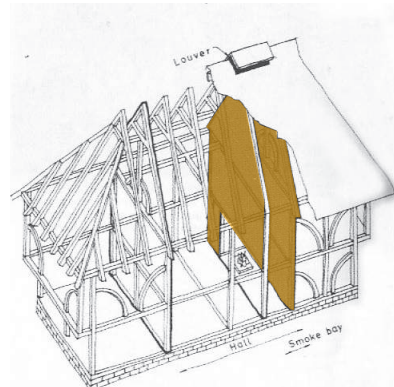
图 1-11 直壁浅穴的半穴居
half cave housing with vertical walls and shallow digging



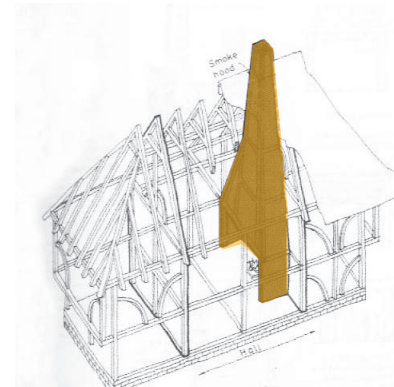
图 1-12 屋垣宫室的内部结构
interior structure of housing



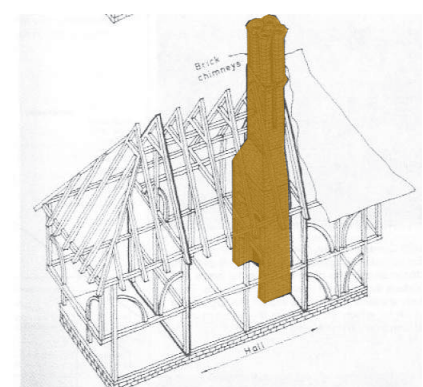
Hall House
Early medieval buildings heated by a central fire required a high ceiling to prevent sparks from causing fires. Thus, whatever warming might come by sitting around the fire in a circle was partly offset by the upward dissipation of heat into a large, high-ceilinged room," Dresbeck, 21.



Smoke Bay
Confined within an entire structural bay, the proto-chimney warms the entire hall while directing the smoke upward through a louvered passage at the roof.



Smoke Hood
The semi-autonomous smoke hood becomes an independent structure and in the process begins to establish spatial separation.

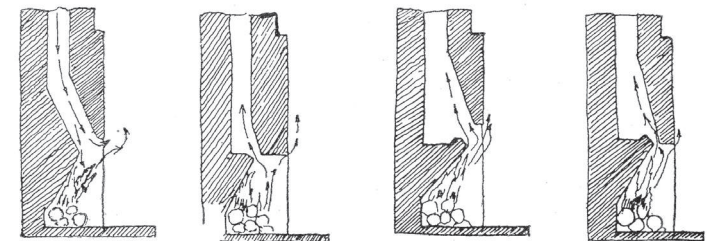


Brick Chimney
The chimney announces its autonomy and initiates the compartmentalization of rooms. Isolated environments cling to the masonry mass to accommodate its captive private thermal demands.

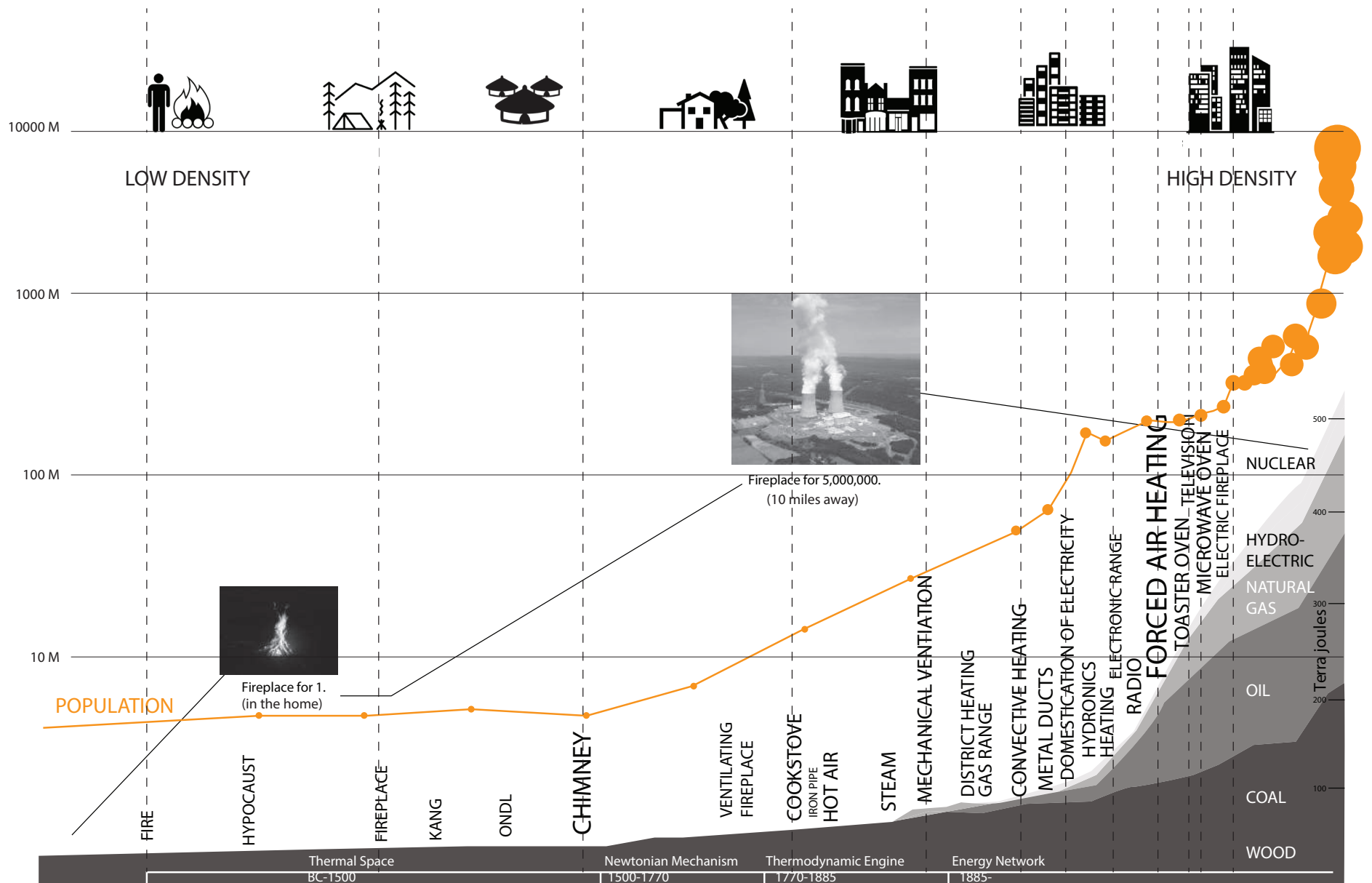
Illustrations from Roxana McDonald, *The Fireplace Book* (The Architectural Press, London, 1984)

FIRE MIGRATES TO WALL

Throughout the evolution of primitive dwellings, the wall becomes a functional entity, created thick enough to embed a fireplace within it. The wall and the chimney becomes about transporting smoke and controlling convection. No longer is it merely a divider of space, but ***transforms the poche into an active surface of convection, heat, and light.***

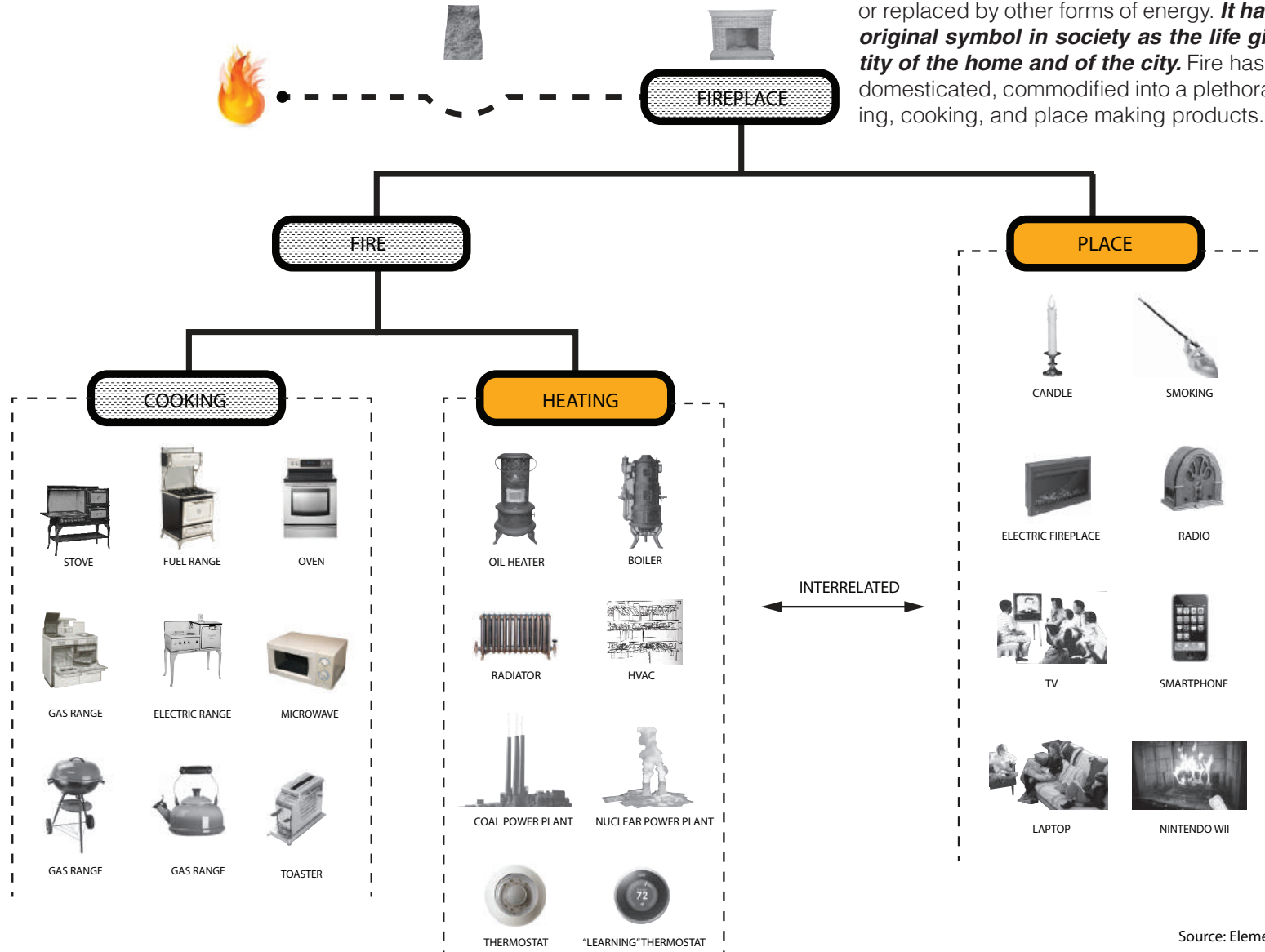


As the population grows and cities densify, the presence of fire continues to diminish, expelled into a distant nuclear plant miles away from the city.

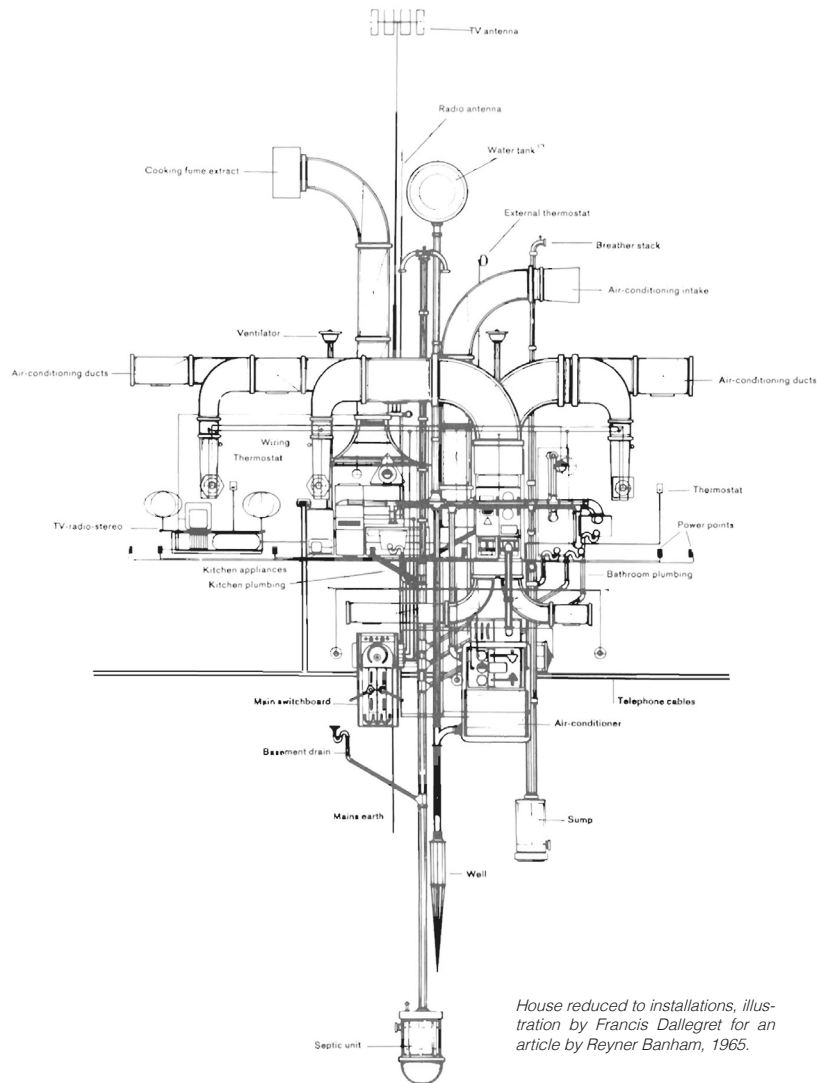


FIRE IS UNDISCOVERED

As a result, the energy of fire has been transformed into a distant element which is being used discretely in industrial buildings, hidden under basements, or replaced by other forms of energy. ***It has lost its original symbol in society as the life giving entity of the home and of the city.*** Fire has become domesticated, commodified into a plethora of heating, cooking, and place making products.



Source: Elements



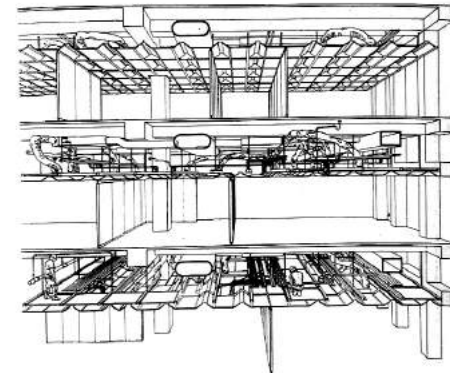
House reduced to installations, illustration by Francis Dallegret for an article by Reyner Banham, 1965.

BUILDING AS A MACHINE: THE LOST OF FIRE

"When your house contains such a complex of piping, flues, ducts, wires, lights, inlets, outlets, ovens, sinks, refuse disposers, hi-fi reverberators, antennae, conduits, freezers, heaters – when it contains so many services that the hardware could stand up by itself without any assistance from the house, why have a house to hold it up?"

-Reyner Banham

The alternative to fire has led to a plethora of equipment used to support and transfer heat, light, and energy throughout buildings. The function of the hearth, which was once the centralized item, has now become the walls, floors, and ceilings of our buildings. **The wall is no longer recognized as an active surface, but rather, a storage for mechanical equipment concealed under a layer of material finish.**



Academic building of the University of California, 1970.

“THE FIREPLACE MAY BE THE FIRST ARCHITECTURAL ELEMENT TO BECOME EXTINCT”

FIREPLACE DEMOLITION PROCESS



Tabletop Firelace
by Gido Wahrmann for Carl
Mertens



Planila by Serge Atallah

Designer fires: instead of a piece of architecture, the fireplace becomes an ultraclean, common table-top object.

Source: Elements

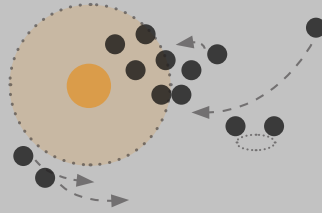


HOW DOES THE REPLACEMENT OF FIRE AFFECT
OUR HUMAN SOCIAL CONSTRUCT?

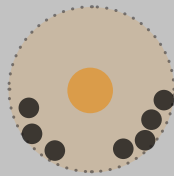
03

**FIRE AS A SOCIAL
PHENOMENON**

FIRE AS SURVIVAL 1000 BC



FIRE AS WANT 1920 AD



FIRE AS OBSOLETE 2010 AD



FIRE AND HEARTH AS SOCIAL PHENOMENON

Gather around the fire.

Due to its effect on the progression of human society, fire has played a crucial part in the development of human social structure. It continuously shapes the formation of community activity through its radiating, multi-functional qualities. As the development of technology relinquishes our dependency on this element, the gathering around fire becomes a strictly social activity, kept around due to its attractive, mesmerizing nature.



**“Now don’t’ start daydreaming!
Soon you’ll have to add more firewood..”**

2010 On-screen prompt in the midst of Nintendo Wii game Fireplacing, stoked through an infra-red wand, for homes that have long since exiled the flame from sight, down to a basement boiler, or distant power station

·
Social engagement through fire, in this virtual sense, is limited to a glowing screen, rendering fire as obsolete.

COMMUNITY AND THE CENTRALIZED SOURCE

Our tolerance for social proximity is directly related to our biological need for heat and light. The radiant nature of fire is able to create higher levels of social intimacy through close human proximity. The absence of fire from society has brought upon a new type of culture formed around the notion of individualism. No longer is society bound together by the radial confinement of the heat, but the quest for equal distribution of heat and light has relinquished the need for physical and social attachment.

CENTRALIZED
SOURCE



DE-CENTRALIZED
SOURCE



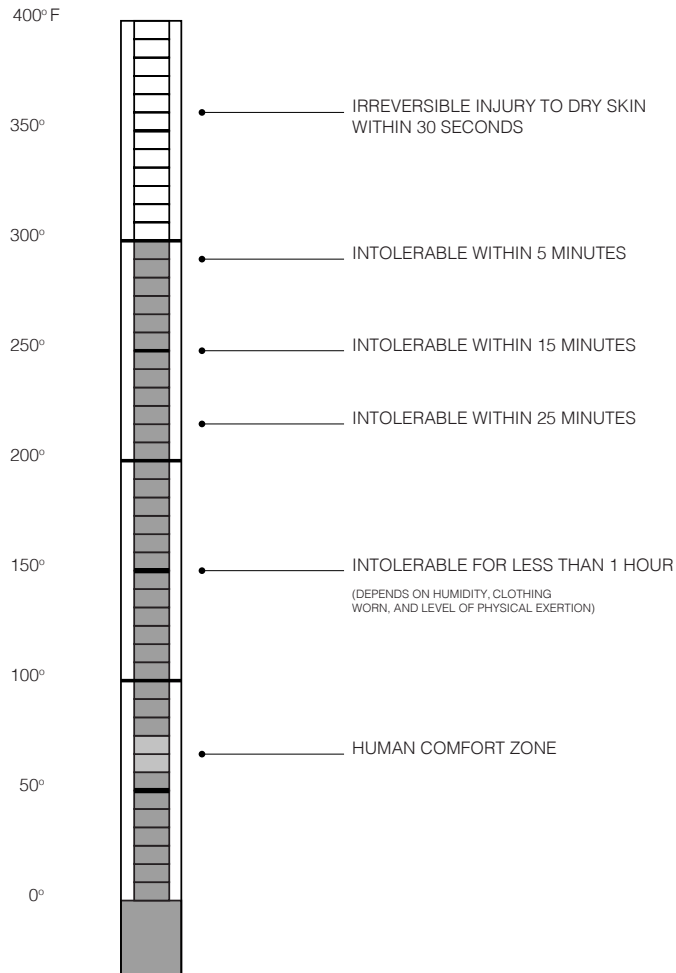
ATTRACTION

DISPERSION

HEAT FROM FIRE

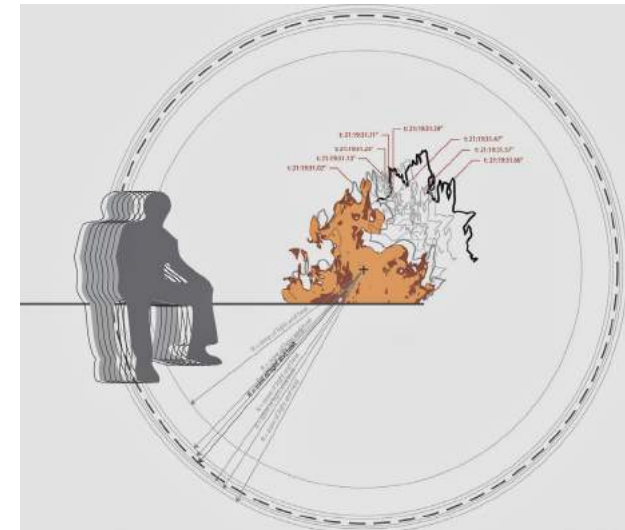
AIR TEMPERATURE

HUMAN RESPONSE

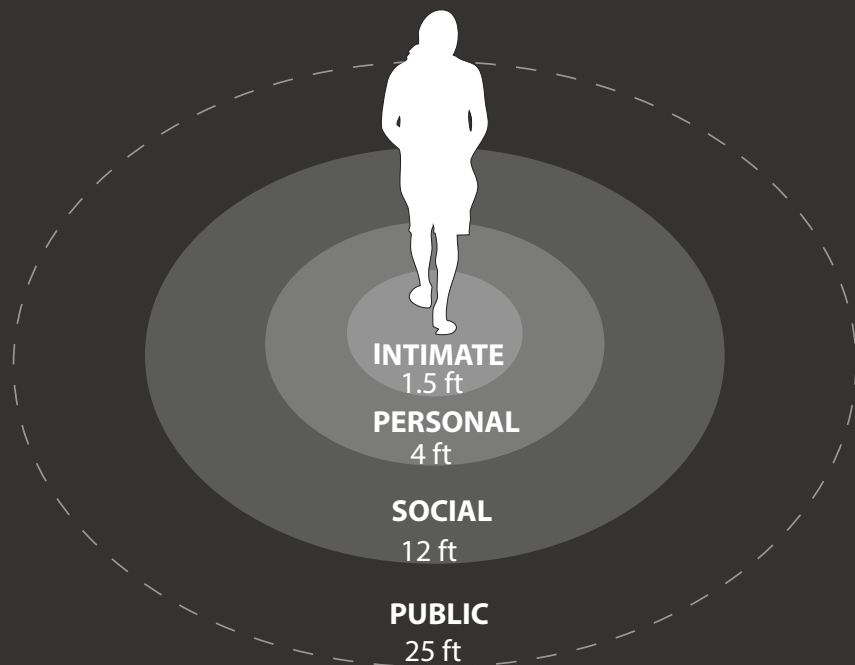


HEAT, LIGHT, AND SPACE

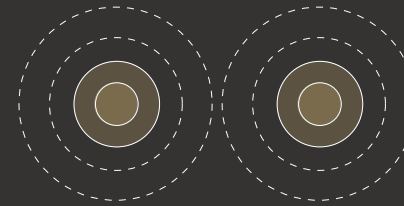
The relation of our interaction with heat and fire is one of attraction and avoidance. Human reactions are the result of our internal temperature measurements in relation to the surrounding environment. When there is fire, our distance to the flames are in relation to the heat that is emitted. When it is cold, we are drawn towards the heat source. When the heat source is too hot, we back away to avoid getting hurt. As a result, heat equals the distance we stand from fire, as well as one another.



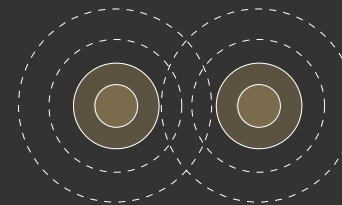
HUMAN PROXEMICS



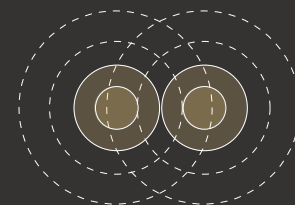
There are four primary levels of human proxemics: intimate, personal, social, and public. The distance between these thresholds pertains to an individualized level of social comfort.



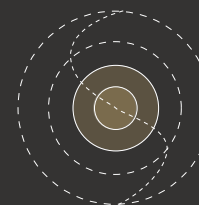
APART SEPARATE



SEPARATE TOGETHER



TOGETHER CONNECTING



CONNECTING INTERSECTING

12-25 ft



4-12 ft



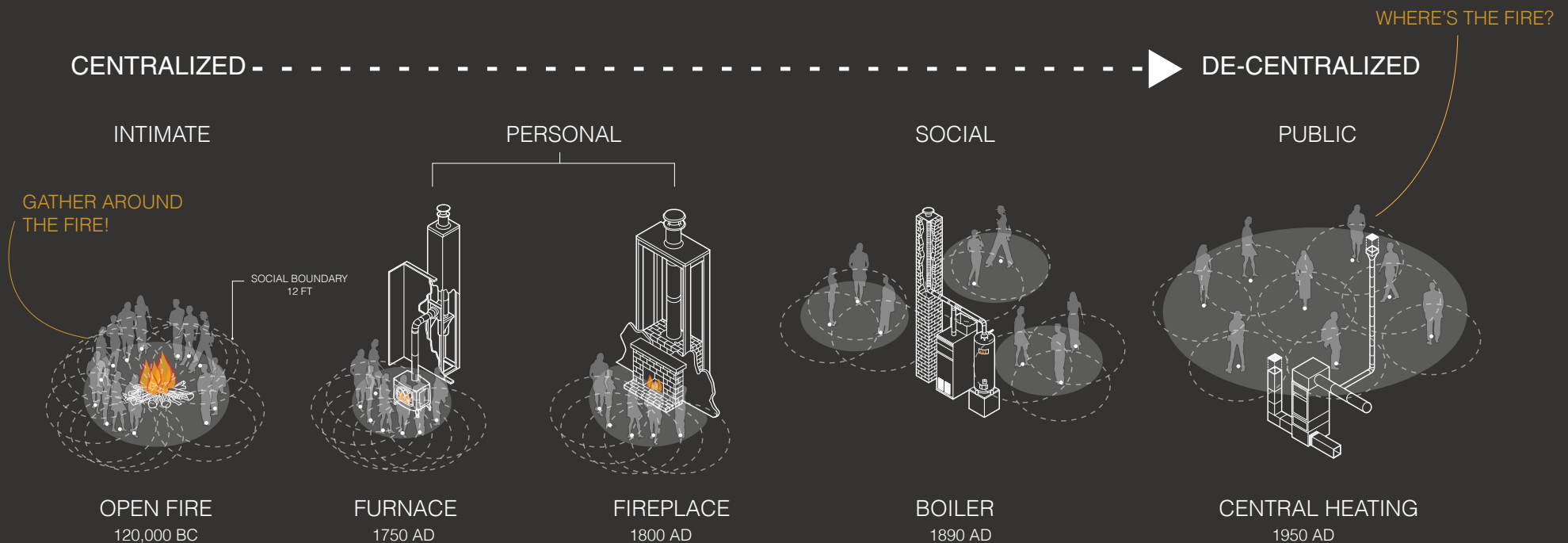
1.5-4 ft



0-1.5 ft

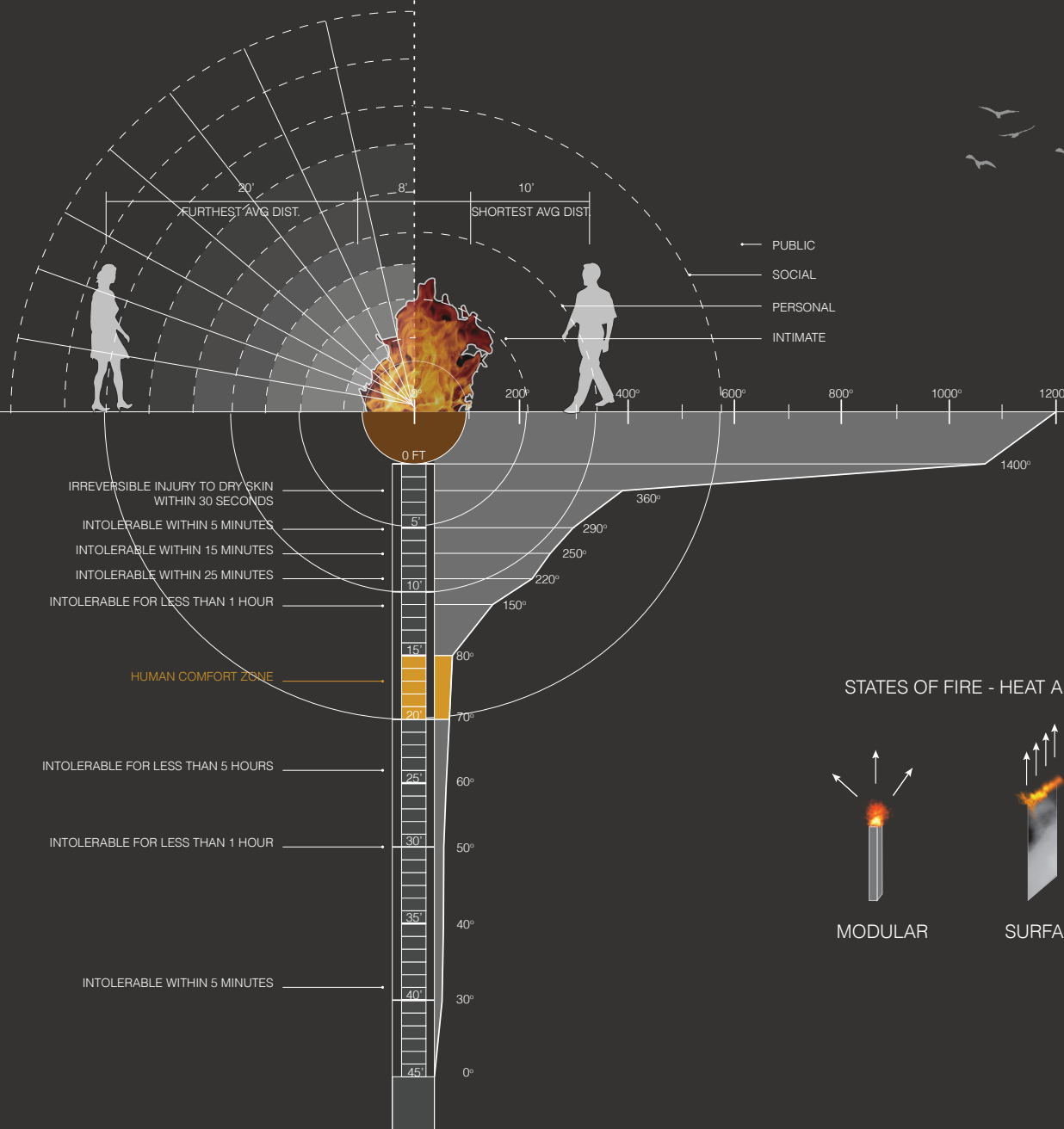


OUR PROXEMITY TOWARDS OTHERS IS DIRECTLY RELATED TO HEAT AND LIGHT DISTRIBUTION

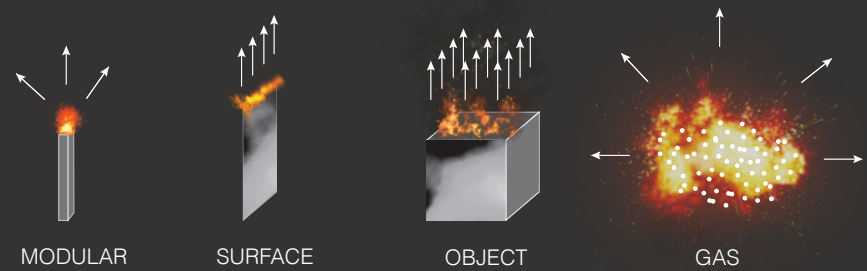


As a result of decentralized individualism rather than collective centralization, our social proxemic tolerance towards one another has become distant due to the lack of biological need for fire.

THE PROXEMIC CULTURE OF FIRE



STATES OF FIRE - HEAT AND LIGHT DISTRIBUTION



HEAT = DISTANCE

STATES OF FIRE



MODULAR



SURFACE



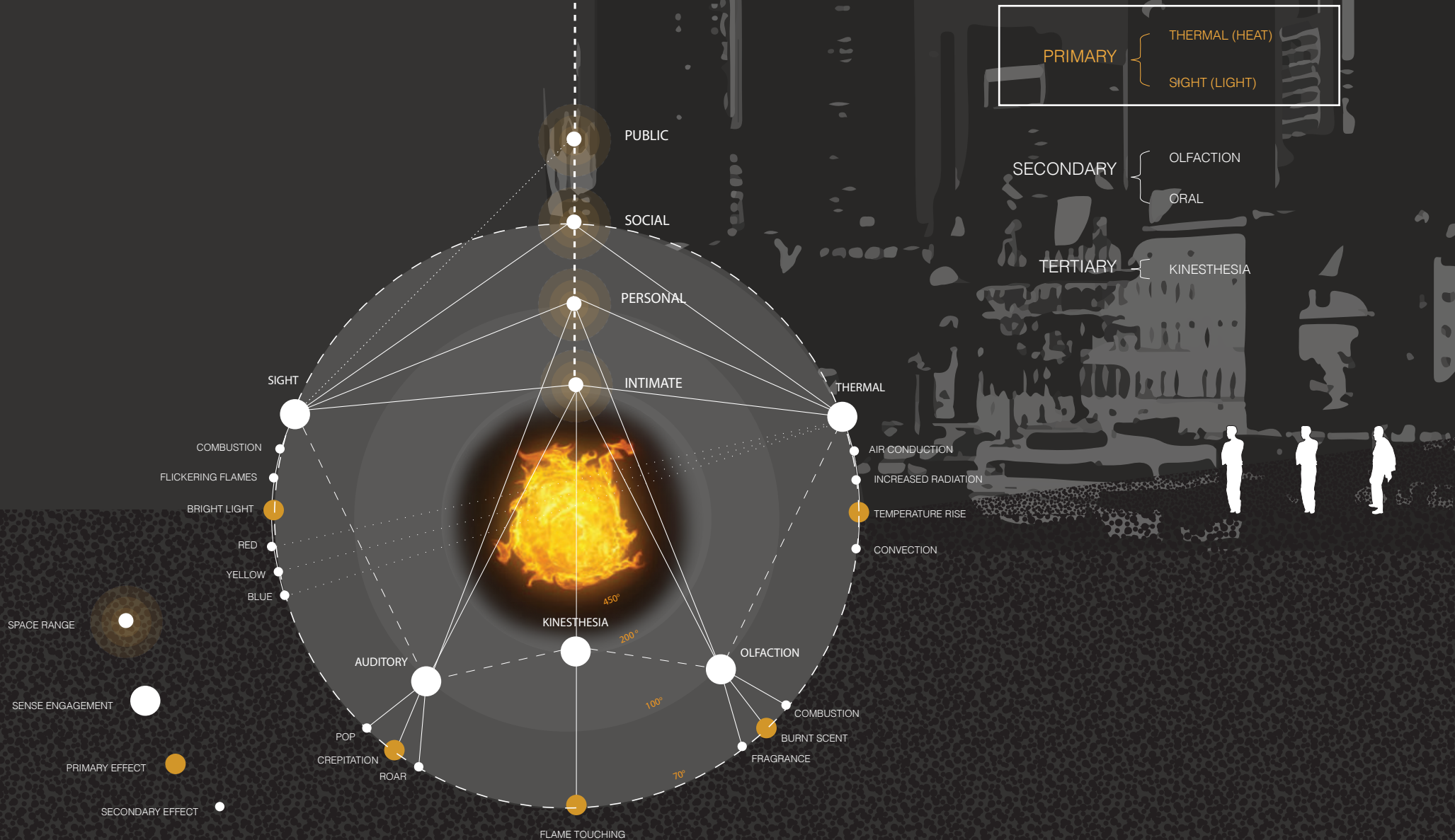
OBJECT



GAS



SENSES AFFECTED BY FIRE





04

CASE STUDY: THE BURNING MAN



BLACK ROCK CITY

Population: 67,000

"Once a year, tens of thousands of people gather in Nevada's Black Rock Desert to create Black Rock City, a temporary metropolis dedicated to community, art, self-expression, and self-reliance. It's a city wherein almost everything that happens is created entirely by its citizens, who are active participants in the experience." -Black Rock City





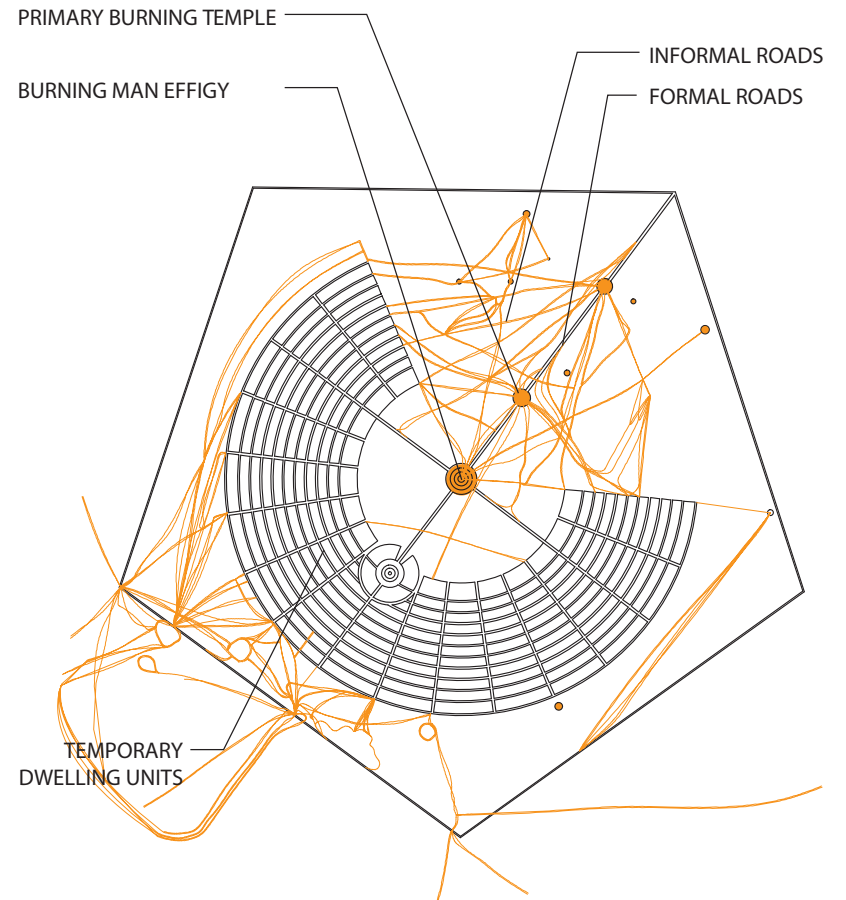
Burning Man Effigy, 2013



Burning Temple of Black Rock City, 2014

CITY OF FIRE

The temporary city is designed around the Burning Man event, where fire is seen as the city's primary organizational structure. Designed artifacts of various scales are implemented throughout the site as its citizens travel to participate in these burnings as a form of community culture.



DECOMMODIFICATION

The Burning Man is a city-scaled community designed and built by its inhabitants, known as "Burners." The process of participation is key in that it is meant to completely release its dwellers from the restrictions of the "default world", or everyday life. The one week metropolis is meant to replenish a primitive society of authenticity, decommodified and pure. Once over, everything is burned, dismantled, and towed away, leaving the inhabitants renewed through the process of self discovery.

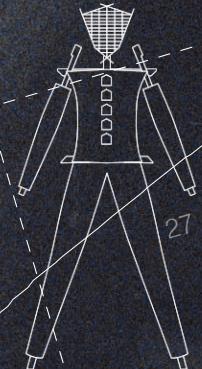


THE BURNING MAN



BLACK ROCK DESERT

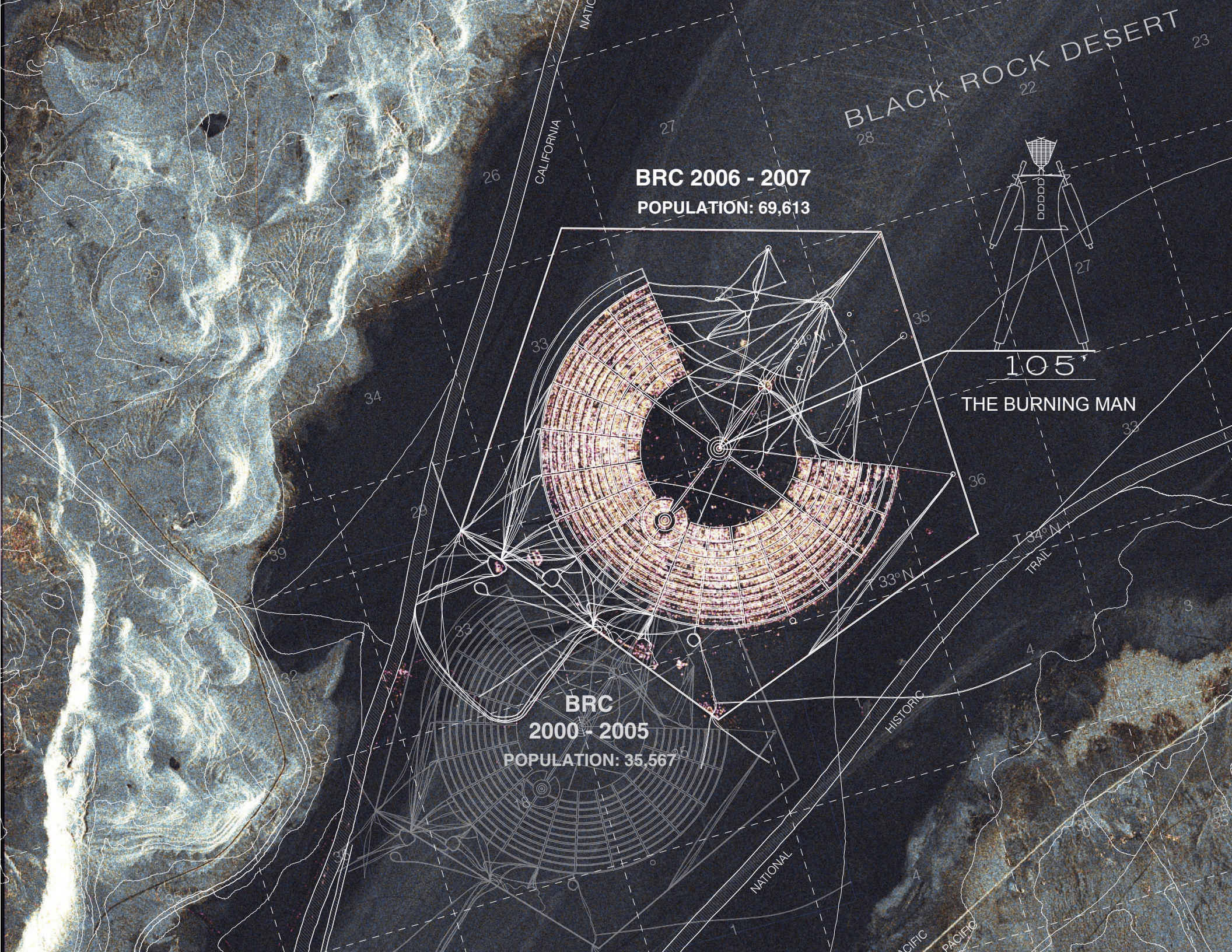
BRC 2006 - 2007
POPULATION: 69,613



105'

THE BURNING MAN

BRC
2000 - 2005
POPULATION: 35,567





A topographic map of the Burning Man site, showing contour lines and a grid. Four locations of the Burning Man Community (BRC) are marked with concentric circular patterns and labeled: BRC 1997 (top left), BRC 1998 (bottom left), BRC 1999 (bottom center), and BRC 2000-2005 and BRC 2006-7 (center right). The map also shows a road network and a river.

**BRC
1997**

MIGRATING CITY

As the Burning Man community continues to expand, the city migrates to different areas in order to accommodate for the masses. The nomadic nature allows for the community to redesign itself as an opportunity for constant urban renewal.

BRC 2006-7

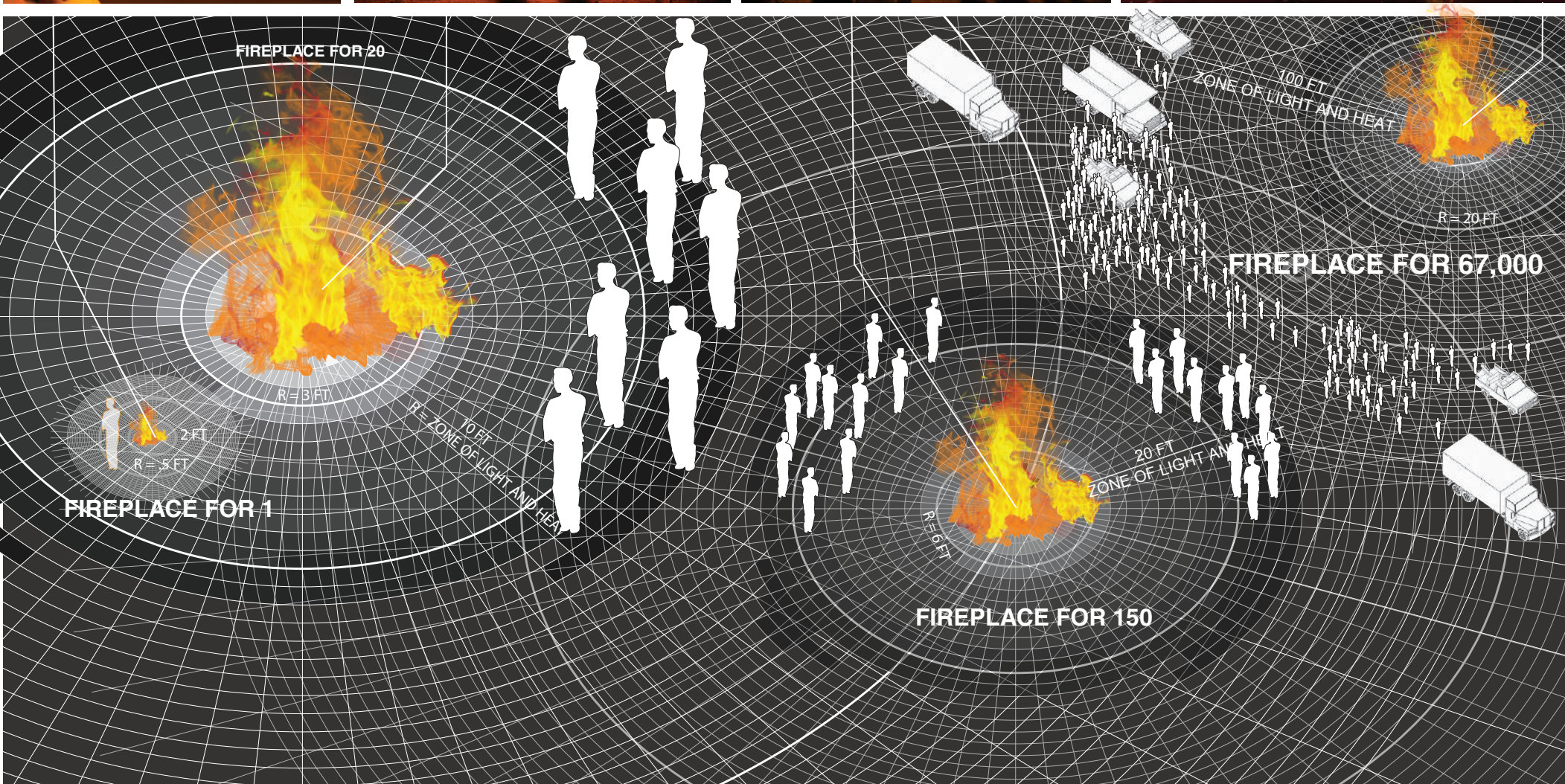
**BRC
2000-2005**

**BRC
1999**

**BRC
1998**

COMMUNITIES OF SCALE

Various scales of human proxemics is achieved through the size of burning artifacts, where the emission of light and heat becomes the defined spatial boundaries. The nature of fire is no longer domesticated or resisted. Rather, it is designed into pieces of art as a form of creative liberation.

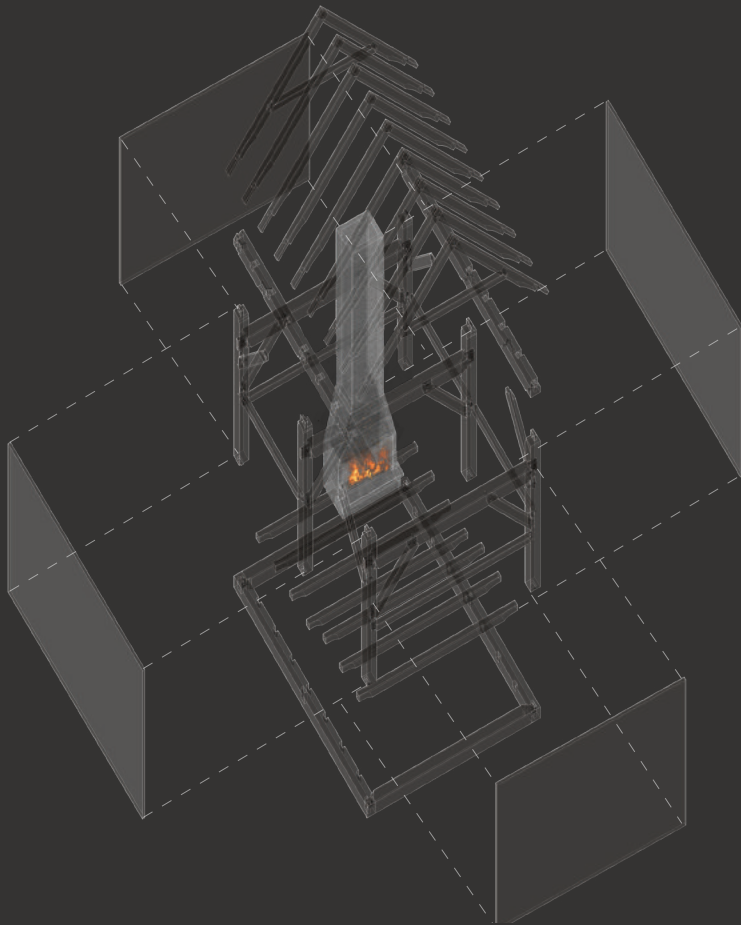




05

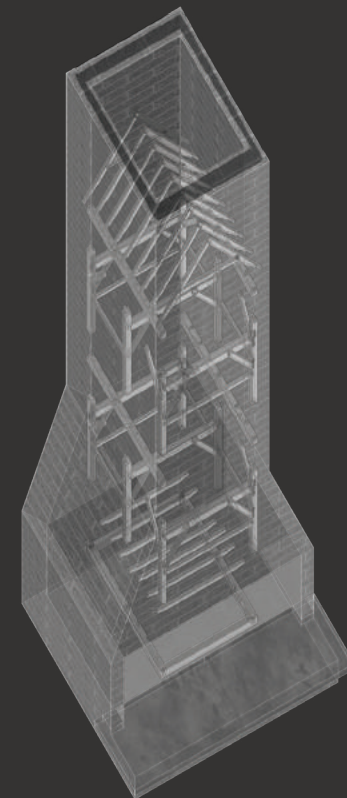
THE BURNING BUILDING

DESIGN OF THE CONTEMPORARY HEARTH



SEMPER'S PRIMITIVE HUT

"Throughout all phases of society, the hearth formed that sacred focus around which took order and shape. It is the first and most important element of architecture. Around it were grouped the other three elements: the roof, the enclosure, and the mound. The protecting negations or defenders of the hearth's flame against the hostile elements of nature."
-Gottfried Semper



INVERTED HEARTH

To further evolve Semper's model, this thesis proposes an alternative architectural typology to Semper's primitive hut by redesigning spatial conditions through the system of the inverted hearth. Here, the hearth becomes the sole architectural element of design. Space is not defined by walls and enclosures, but through the control of fire in a raw environment.

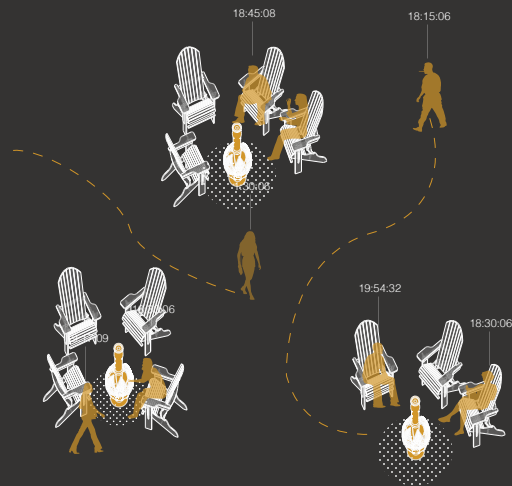
SCALE 1



INTIMATE: The first study occurs on the sidewalk corner of a cultural neighborhood in Philadelphia called the Italian Market. The time is 3:35 PM with a temperature of 35 degrees and a man is found selling groceries along the street side with a burning metal bin 2 feet in diameter at his side. Occasionally, the man, and others, would walk towards the fire and dispose of cardboard boxes and other combustibles within the fire. It had become apparent that as workers were getting rid of excess boxes into the fire due to lack of storage space and disposal options outdoors. The placement of the can on the street corner was deliberately located for others to find temporary relief within the raw environment.



SCALE 2

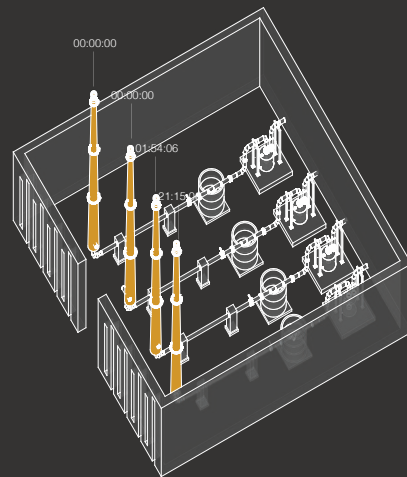


EVENING

SOCIAL: The second study takes place in an outdoor winter garden in which fire pits are placed in various locations for external comfort. Here, the formation of community is observed as people congregate according to seek thermal comfort. The attractiveness of the hearth allows people to gather in the raw environment which allows for congregation and social interactions dictated not through physical boundaries, but immaterialized space of heat and light.

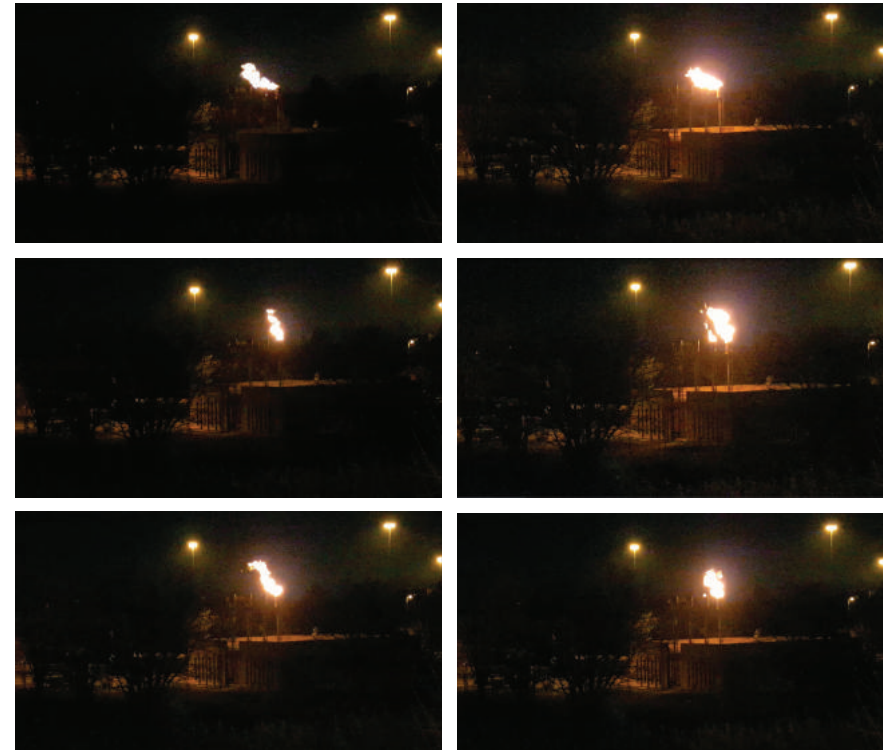


SCALE 3

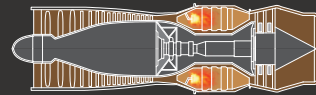


NIGHT

PUBLIC: The third scale takes place in a water purification facility located miles away from the city. Here, the hearth takes the form of a flare stack in which the combustion process is used for the purpose of burning excess methane gas that is produced on site. Fire is used as a means to cleanly burn the fuel without environmental damage. The public scale allows the comfort of the hearth to be experienced from a distant level. Although the heat is not felt, fire's attractive nature draws a visual nostalgia miles away.

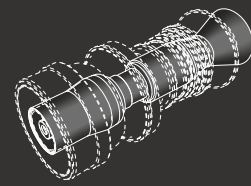


The model of the inverted hearth is derived from the logic of the gas turbine.



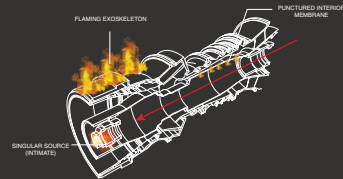
GAS TURBINE SYSTEM

It features an inset volume within a hallowed exoskeleton that creates chambers in which the combustion process occurs.



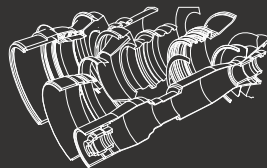
INTERIOR VESSEL

Heat and light distribution is controlled through a language of fire mechanisms which determines the typology of the space.

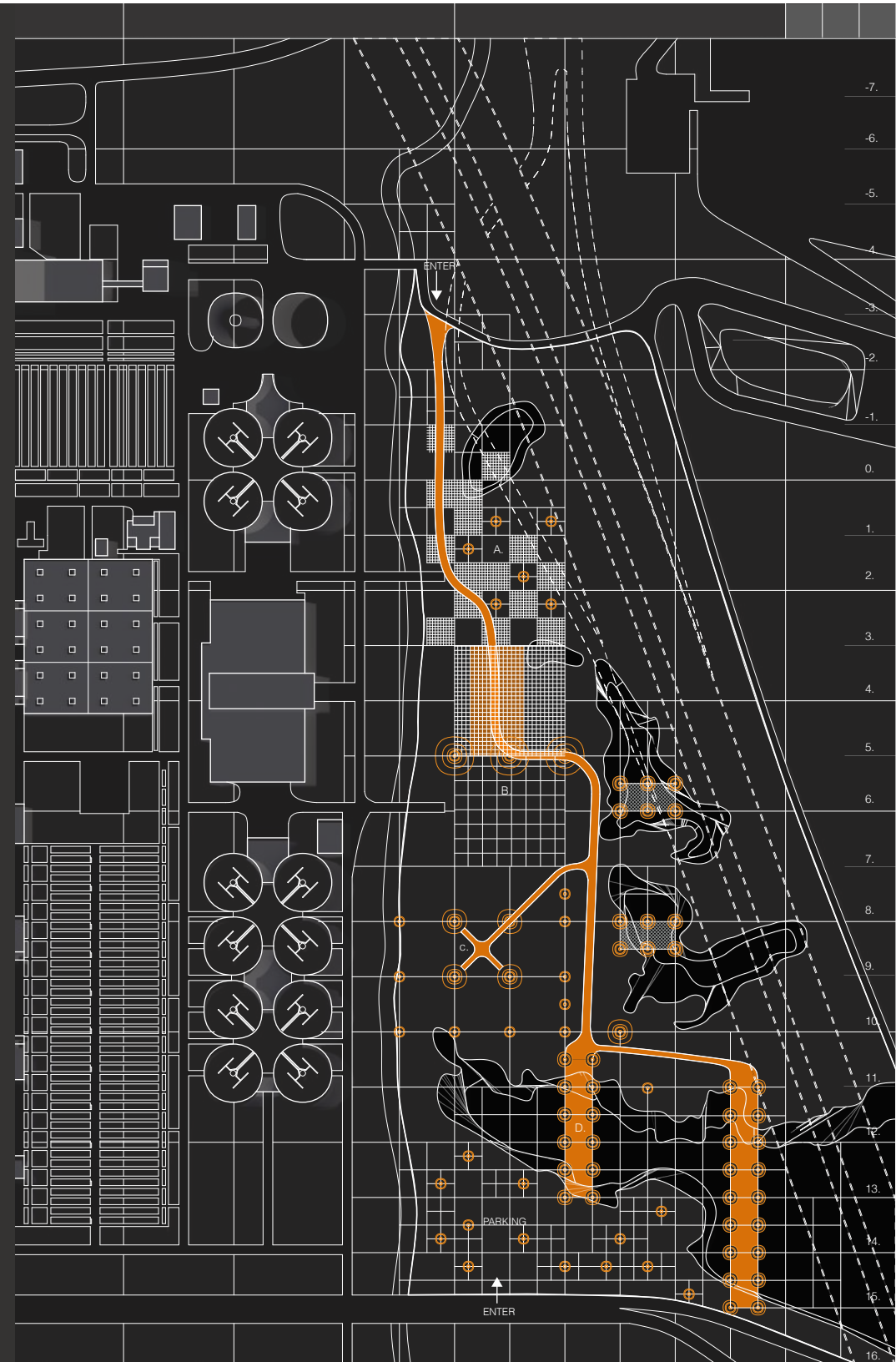


FIRE CONTROL

The membrane is a layered catalyst which can be controlled at different scales through punctured membranes and fuel distribution which transforms the habitation of the space.



LAYERED CATALYST



MOBILITY



SCALE



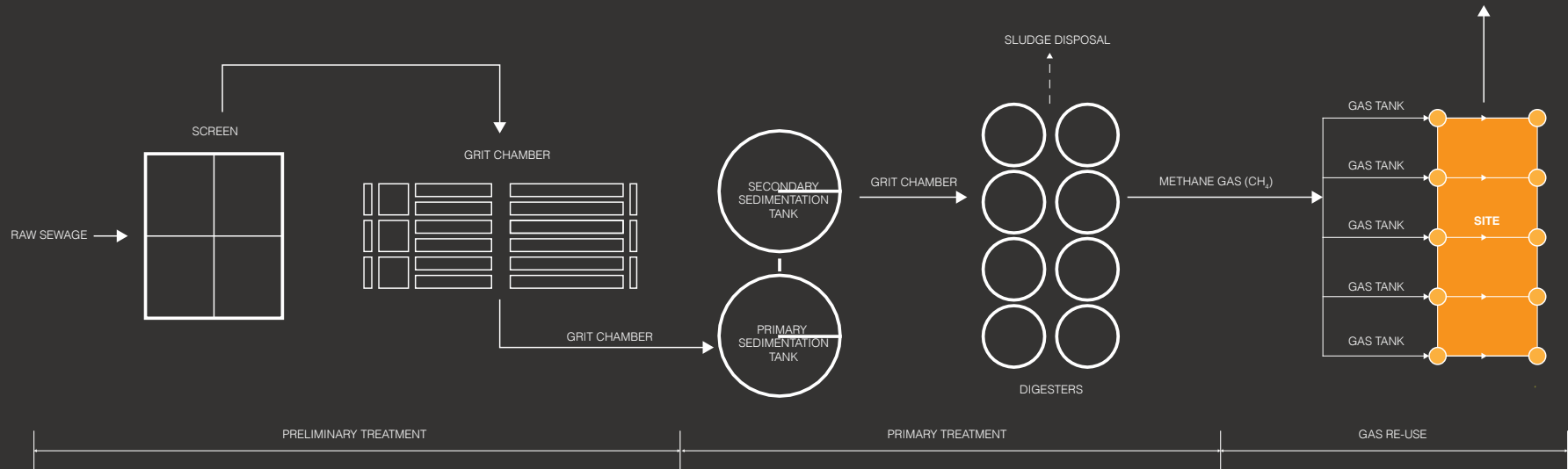
DUPLICATION



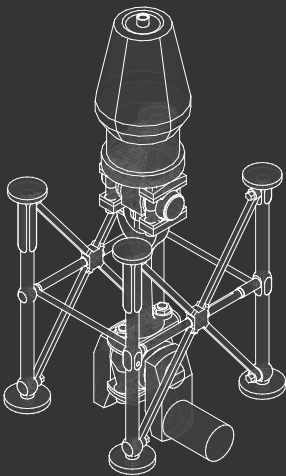
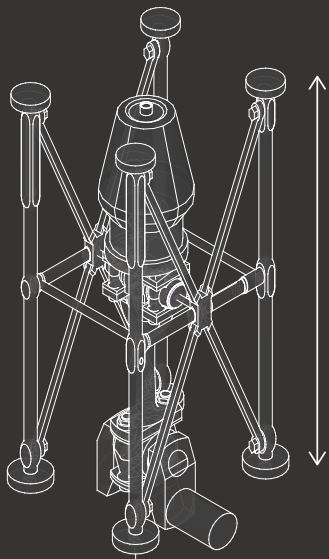
ASSEMBLY



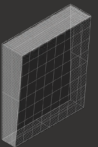
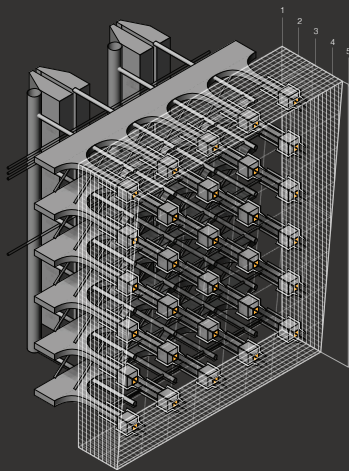
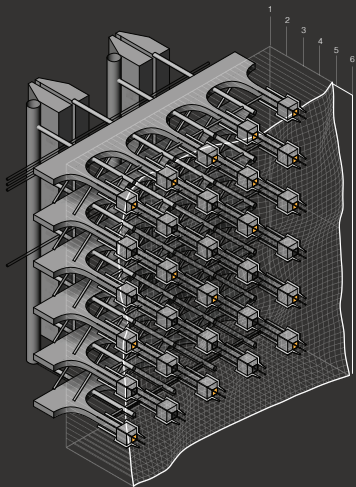
COMBUSTION CONTROL



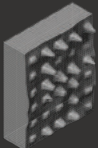
VERTICAL CONTROL MODEL



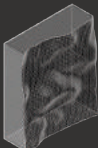
HORIZONTAL CONTROL SYSTEM



PLANAR

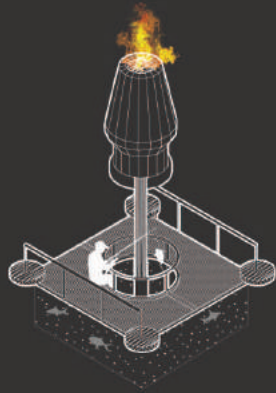


PIXELATED



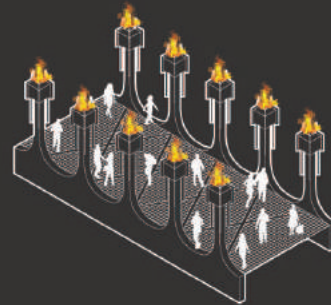
FLUID

INTIMATE



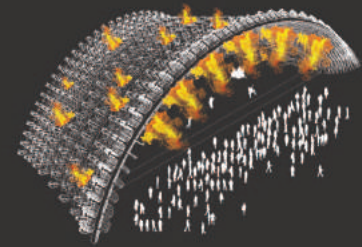
FISHING HOLE

SOCIAL



BRIDGE

PUBLIC



CONCERT HALL





BIBLIOGRAPHY

BOOKS

Banham, Reyner. *The Architecture of the Well-tempered Environment*. Chicago: University of Chicago, 1969.

Debaigts, Jacques. *The Modern Fireplace*. New York: Van Nostrand Reinhold, 1975.

Egan, M. David. *Concepts in Building Firesafety*. New York: Wiley, 1978.

Galiano, Luis. *Fire and Memory on Architecture and Energy*. Cambridge, Mass.: MIT Press, 2000.

Hall, Edward T. *The Hidden Dimension*. Garden City, N.Y.: Doubleday, 1966.

Hall, Edward T. *Handbook for Proxemic Research*. Washington, D.C.: Society for the Anthropology of Visual Communication, 1974.

Heschong, Lisa. *Thermal Delight in Architecture*. Cambridge, Mass.: MIT Press, 1979.

Kelly, Alison. *The Book of English Fireplaces*. Feltham: Country Life Books, 1968.

Koolhaas, Rem, and Mass Cambridge. *Elements of Architecture*. Venice: Marsilio, 2014.

Mateo, Jose. *Earth, Water, Air, Fire: The Four Elements and Architecture*.

Moe, Kiel. *Thermally Active Surfaces in Architecture*. New York: Princeton Architectural Press, 2010.

Przetak, Louis. *Standard Details for Fire-resistive Building Construction*. New York: McGraw-Hill, 1977.

Sommer, Robert. *Social Design: Creating Buildings with People in Mind*. Englewood Cliffs, N.J.: Prentice-Hall, 1983.

WEBSITES

"1986." *Burning Man*. Accessed December 15, 2015. <http://burningman.org/timeline/>.

"Ch 07 Heavy Timber and Mill Construction." *Ch 07 Heavy Timber and Mill Construction*. Accessed December 15, 2015. <http://www.slideshare.net/sno-shoesam/ch-07-heavy-timber-and-mill-construction>.

"The Culture | Burning Man." *Burning Man*. Accessed December 15, 2015. <http://burningman.org/culture/>.

"Engineering and Construction." *FIRE-RESISTIVE HEAVY TIMBER CONSTRUCTION*. Accessed December 15, 2015. <http://www.thecivilbuilders.com/2013/09/fire-resistive-heavy-timber-construction.html>.

"FIRE - FLAMES Modeling & Simulation Software by Ternion." *FLAMES Modeling & Simulation Software by Ternion*. Accessed December 15, 2015. <http://www.ternion.com/fire/>.

"Fundamentals of Building Construction, Materials & Methods, 5 Th Edition Copyright © 2009 J. Iano. All Rights Reserved. History Simple Timber-Framed." *Presentation "Structures"*. Accessed December 15, 2015. <http://slideplayer.com/slide/1421795/>.

Wolchover, By. "Why We Are Drawn to Fire." *LiveScience*. April 23, 2012. Accessed December 15, 2015. <http://www.livescience.com/19853-fire-fascination.html>.

JOURNALS

Fessler, Daniel M. T. *A Burning Desire: Steps toward an Evolutionary Psychology of Fire Learning*. Emmitsburg, MD: [National Emergency Training Center], 2006.

Langenbach, R. "Better than Steel? (Part 2)." *Structures and Architecture New Concepts, Applications and Challenges*, 2013, 122-39.

